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Journal
Orthopedic reviews, 10(3)

ISSN
2035-8237

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Publication Date
2018-09-01

DOI
10.4081/or.2018.7688

Peer reviewed

Vertical patellar dislocation: A pediatric case report and review of the literature

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Abstract

Vertical patellar dislocations (VPDs) are a rare event, and even more so among pediatric female patients. There have been less than 30 vertical patellar dislocations reported in the literature since the first in 1844. In this type of dislocation, the patella rotates about its vertical axis with the articular surface facing either medially or laterally. The mechanism of injury for a VPD can be broadly divided into two themes: a twisting injury or direct impact to the medial or lateral edge of the patella. We present a 10-year-old girl with a VPD after experiencing a twisting injury when descending a playground slide. The purpose of this study is to present a case report and review of the literature on vertical patella dislocations, including mechanisms of injury and suggested methods of treatment. We aim to provide a comprehensive understanding of the various categories of patella dislocations to alleviate confusion when classifying patellar dislocations. Furthermore, we provide clear suggestions for reduction methods and techniques with regards to vertical patellar dislocations, including a suggested protocol for an irreducible patella.

Case Report

A 10-year-old female sustained a twisting injury to her left knee as she was descending a spiral playground slide. She presented to the ED with her leg locked in extension and experiencing severe pain. She was unable to bear weight on her left leg. The patient had no other injuries but did complain of tingling in the lower left leg. She had no muscle weakness and no loss of sensation from the knee distally. On physical examination, the patella was obviously mal-positioned and was rotated 90°, facing perpendicular to its natural plane (Figure 1). The performed radiograph confirmed a rotation of the patella of 90° about its vertical axis, positioned within the trochlear groove between the femoral condyles (Figure 2). The Orthopaedic Service was consulted and evaluated the patient in the Emergency Department. Given the patient's thin body habitus, the patella could be easily palpated and it was determined that the articular surface was facing laterally. A reduction was attempted in the Emergency Department under conscious sedation with etomidate. The patella was successfully reduced via vertical traction to lift the medial side and lateral pressure on the anterolateral edge of the patella to allow it to rotate back to its anatomic position. Reduction was confirmed with radiographic imaging (Figure 3) and restoration of normal motion of the knee passively. After waking from sedation, the patient reported that her pain had markedly improved. A knee immobilizer was placed after reduction and she was discharged from the ED.

Upon follow-up in clinic, an MRI was ordered and revealed medial patella and anterolateral femoral condyle bone contusions, mild femoral trochlear dysplasia, and medial patella femoral ligament sprain. There were no osteochondral defects or loose bodies detected in the MRI. The knee immobilizer was then transitioned to a hinged knee brace and she was able to begin range of motion exercises. She was referred to physical therapy for strengthening and patella stabilization. At four-month follow-up, the patient had returned to normal activities with full range of motion and no limitations in function nor pain symptoms. She subsequently had no recurrent episodes of dislocation or pain symptoms and had not needed follow-up at 24-months post-injury

Discussion

A vertical patellar dislocation (VPD) is a rare type of patellar dislocation and is characterized by a vertical axis rotation of the patella.

Patellar dislocation classification systems have been proposed in the literature to varying extents, with one of the more recent ones considering a tendinous tear (quadriceps or patellar tendon) as criteria for a category.[1] The classification system proposed here discusses patella dislocations in the absence of complete tendinous rupture for consideration of a successful closed reduction.

A useful way to think about and discuss patellar dislocations is to classify them based on the following characteristics: i) location of patella relative to its anatomical space; ii) rotation about its horizontal or vertical axis; and iii) the directionality of the articular surface. At the first level, patellar dislocations can be divided into two major categories based on the location of the patella relative to its anatomical space: intra-articular *vs* extra-articular dislocations.[2] An extra-articular patella dislocation is one in which the patella is no longer in its anatomical space anterior to the femoral condyles, but instead is found either medially, laterally, superiorly or inferiorly (Figure 4A).[1,2] Conversely, intra-articular patellar dislocations are those in which the patella remains in its anatomical space anterior to the femoral condyles, but is dislocated in that it is rotated about its vertical/horizontal axis (Figure 4B). At the second level, patellar dislocations can be further divided based on the axis of rotation. An intra-articular horizontal patellar dislocation is rotated about its horizontal axis (Figure 4B.1) while an intra-articular vertical patella dislocation is rotated about its vertical axis (Figure 4B.2). An extra-articular horizontal patellar dislocation is one in which the patella is rotated about its horizontal axis and lies either above or below the trochlear groove (Figure 4A.1). An extra-articular vertical patellar dislocation is one in which the patella is rotated about its vertical axis and is wedged against the lateral or medial femoral condyle (Figure 4A.2). There are also extra-articular patellar dislocations, which include the most com-

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Key words: Vertical patellar dislocation; patella dislocation; lateral patella dislocation.

Contributions: UNU, literature review, manuscript writing/editing, and final approval; CSS, case acquisition, conceptual design, Literature review, manuscript writing/editing and final approval

Conflict of interest: the authors declare no potential conflict of interest.

Received for publication: 20 March 2018.
Revision received: 11 June 2018.
Accepted for publication: 14 June 2018.

Orthopedic Reviews 2018;10:7688
doi:10.4081/or.2018.7688

mon form, with no axial rotation but instead are laterally, medially, superiorly, or inferiorly displaced (Figure 4A.3). In this instance when the patella is medially or laterally displaced with no axial rotation, it ends up revolving around the joint space, with the articulation between the femur and tibia as its axis of revolution (Figure 4A.3c - 4A.3d). The most common form of patellar dislocation is the extra-articular lateral patellar dislocation (Figure 4A.3d), which is known as a lateral patellar dislocation.

An extra-articular lateral/medial patellar dislocation can be misclassified as an extra-articular vertical patella dislocation because the patella is sometimes so extensively laterally displaced that it is revolves around the joint space and ends up medial/lateral to the femoral condyles. To distinguish them from each other, the third level of classification is determined by the directionality of the patellar articular surface. In an extra-articular vertical patella dislocation, the articular surface is facing away from the condyles and the patella is wedged against either the medial or lateral femoral condyle (Figure 4A.2a - 4A.2b). In an extra-articular lateral/medial patellar dislocation with no axial rotation, the articular surface is facing towards the femoral condyles (Figure 4A.3c - 4A.3d). This level of classification is also relevant to intra-articular horizontal/vertical patella dislocations. An intra-articular horizontal patella dislocation results in either the inferior or superior pole of the patella being wedged between the condyles with the articular surface facing superiorly or inferiorly (Figure 4B.1a - 4B.1b).[3] A vertical patella intra-articular dislocation results in either the medial or lateral edge of the patella being wedged between the femoral condyles and the articular surface facing medially or laterally (Figure 4B.2a - 4B.2b).[1]

Vertical patellar dislocation was first described by Cooper et al. in 1844 and remains a rare occurrence with less than 30 events reported in the literature since then.[4] Intra-articular and extra-articular VPDs are similarly common with 14 intra-articular VPDs definitively reported in the literature compared to 11 extra-articular VPDs definitively reported. Of the cases reviewed, more than half of VPDs have occurred in males under the age of 20. Reichel suggests that the laxity of the ligaments of growing children allows the patella to more easily dislocate.[5] In the pediatric female population, VPD is a rare event with only 4 cases reported since the first in 1984.[6-9]

The exact mechanism of sustaining a VPD is not clearly understood but there have been several propositions in the literature describing basic mechanisms. Twisting injuries have been the most commonly reported.[6,9-14] Raj *et al.* suggests that a VPD sustained from a twisting injury occurs when the femur is forcibly internally rotated on a planted, externally rotated tibia while the knee is in flexion.[14] Accidents with direct impact to the medial or lateral patellar edge have also been commonly reported. Colville first suggested that a direct blow to the lateral side of the patella while the knee is in extension could cause the patella to dislocate and rotate along its vertical axis with the articular surface facing medially.[15] This has been described by several authors.[15-18] Garrison described a similar mechanism where the blow is directed at the medial patellar edge, causing the articular surface to face laterally,[8] which has been described less often in the literature.[19-21] Traumatic injuries with non-specific direc-

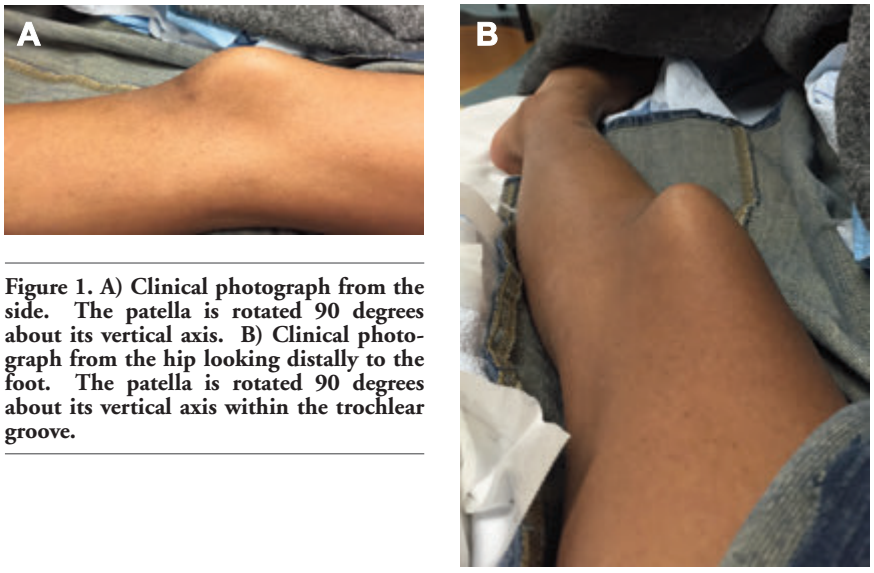


Figure 1. A) Clinical photograph from the side. The patella is rotated 90 degrees about its vertical axis. B) Clinical photograph from the hip looking distally to the foot. The patella is rotated 90 degrees about its vertical axis within the trochlear groove.

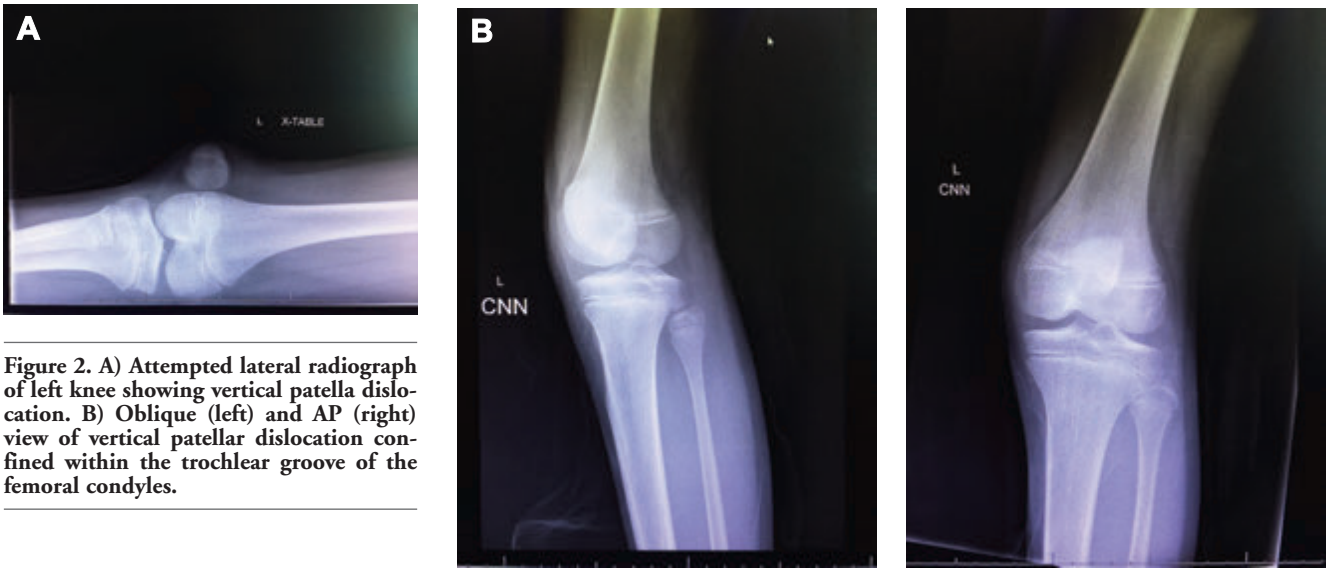


Figure 2. A) Attempted lateral radiograph of left knee showing vertical patella dislocation. B) Oblique (left) and AP (right) view of vertical patellar dislocation confined within the trochlear groove of the femoral condyles.

tionality have also been described and include motorcycle accidents,[22,23] a collision with the wall while running,[14] falling out of a window,[24] a rollercoaster accident,[25] falling down a staircase,[26] crashing while operating a lawnmower,[27] falling off a ladder,[17] slipping on ice,[28] and a soccer collision.[29] Before reduction can be completed, it is important to determine the direction of the patella articular surface. Past authors have described inadvertently rotating the patella 180° further about its vertical axis when trying to reduce a VPD[11] or causing a VPD when trying to reduce a laterally dislocated patella.[1,7] Knowing the position of the patellar articular surface can inform one's reduction technique to help prevent further injury. For example, an extra-articular VPD that is wedged against the medial/lateral femoral condyle with its articular surface facing laterally, may first require a downward pressure to disengage the patella from the femoral condyle before proceeding with reduction. The direction of the articular surface will determine whether the patella will need to be rotated laterally/medially while exerting a medial/lateral force.[13,14] In this case, applying an initial lateral/medial pressure can cause the patella to further lodge against the femoral condyle or further rotate to final 180° position.[13] Likewise, it is important to discern the patellar articular surface for an intra-articular VPD to determine whether to apply medial or lateral pressure to reduce it. Our patient's patella was successfully reduced under conscious sedation with one attempt. As the patella was palpated and determined to have its articular surface facing laterally (such as in Figure 5.2B), vertical traction to lift the medial side and lateral pressure on the

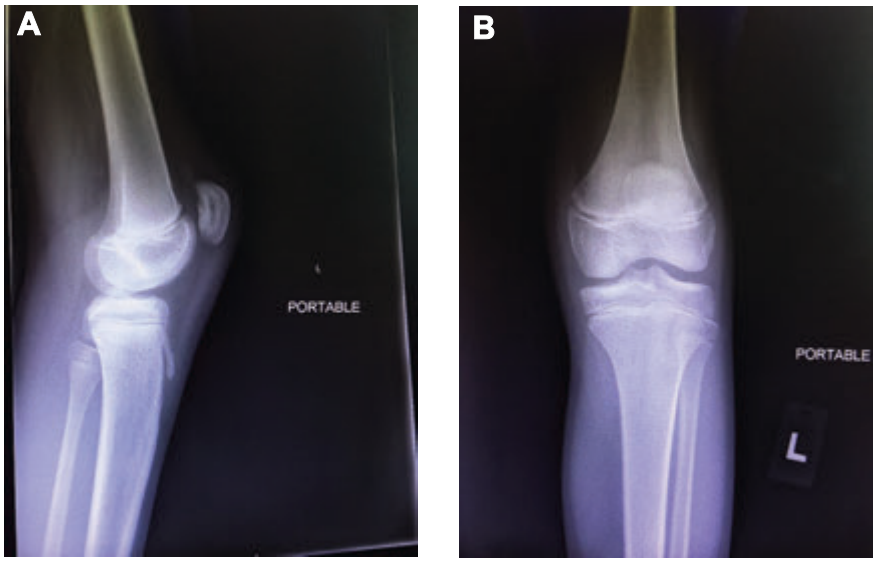
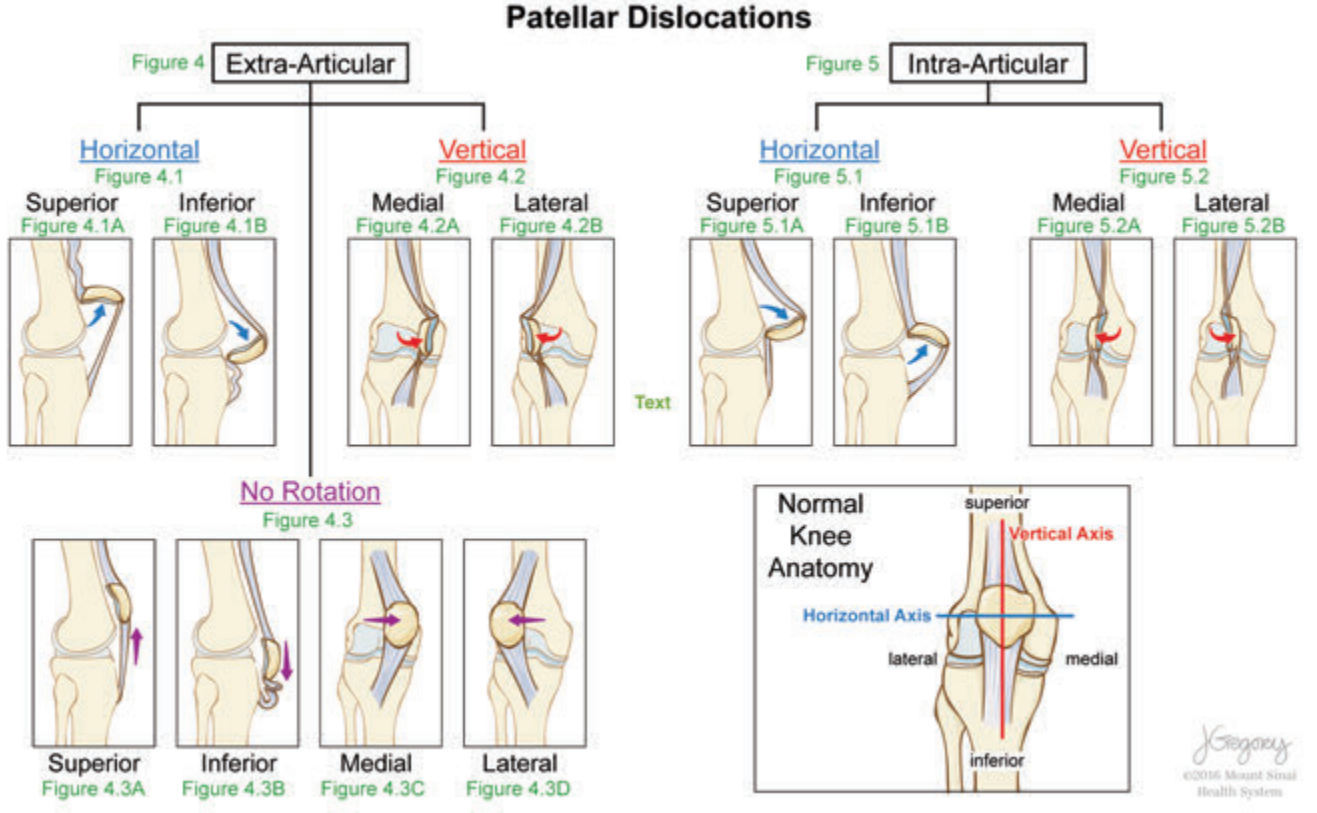


Figure 3. Lateral (left) and AP (right) post-reduction views of the knee, showing reduced patella.



Figures 4 and 5. Patellar dislocations: Flow chart that distinguishes extra-articular and intra-articular dislocations. Straight arrows indicate direction of patellar movement without axial rotation. Curved arrows indicate horizontal or vertical axial rotation. A) Extra-articular patellar dislocations. Patella is dislocated and is no longer in its anatomical space anterior to the femoral condyles. B) Intra-articular patellar dislocations. Patella is dislocated but remains within its anatomical space anterior to the femoral condyles. Illustration by Jill K Gregory, CMI. Printed with permission of ©Mount Sinai Health System.

anterolateral edge of the patella was applied to reduce the patella.

We recommend a closed reduction as the first line of treatment in the absence of ipsilateral fractures or hemarthrosis.[6,22,23,25] Of note, Corso et al. stated that extra-articular VPDs lodged against the lateral femoral condyle warrant open reduction.[19] However, a closed reduction of an extra-articular VPD was achieved as early as 1982.[13] It was not specified whether this was a closed reduction performed under conscious sedation or general anesthesia, however it was the first closed reduction to be described in relation to a VPD. Rao et al. described two successful reductions under conscious sedation in 1997 demonstrating that open reduction or closed reduction under general anesthesia is not necessarily indicated.[14] However, the need for conscious sedation or general anesthesia should be determined on a case by case basis and we suggest the initial use of conscious sedation if the case permits.

A patellar dislocation may be irreducible due to an intact retinaculum, indicating an open reduction to be performed.[27] Out of the three cases that described VPDs in obese patients, all of them underwent open reduction after several unsuccessful attempts at closed reduction.[6,9,28] According to Carragher *et al*., obesity and hemarthrosis of the patient made palpation of bony landmarks more difficult.[6] This suggests that closed reductions might be more difficult to achieve in obese patients with this sort of injury.

Multiple unsuccessful attempts at closed reduction increase the risk of osteochondral fragments.[28] If an attempt at closed reduction fails, we suggest attempting a procedure under general anesthesia rather than additional attempts under sedation. Examples of such procedures include percutaneous approaches and an open reduction. Two cases were reported where percutaneous reduction was completed. Alioto (1994) described the use of a Schanz screw as a reduction tool for distraction after three unsuccessful attempts at closed reduction. The patient was taken to the operating room and a small hole was drilled in the anterior surface of the patella towards the articular surface. A 4.5mm Schanz screw was inserted into the hole and was used to provide distraction and lateral rotational force to reduce the patella.[16] Wajid *et al.* (2006) described the use of an A-O clamp after unsuccessful attempts at closed reduction under conscious sedation and general anesthesia.[25] The A-O clamp was percutaneously inserted anterior to the patella and secured it to prepare for distraction. Once the knee was hyperextended, the patella was distracted anteriorly and rotated to reduce it. In both cases the patient experienced minimal trauma and had uneventful recoveries. Since gripping the patella with a clamp is less traumatic than drilling a hole in it, we would suggest using a clamp if a percutaneous approach is attempted.

Few complications following closed reduction of VPDs were reported in the literature. As mentioned, the risk of further rotation of the patella to 180° is of concern, as well as multiple unsuccessful attempts at closed reduction leading to the presence of osteochondral fragments, which can cause swelling, pain, and the locking of the joint subsequent to reduction.[30,31] Patella dislocations cause damage to the surrounding tissue, which may result in a repeat dislocation. In our literature review, patients treated with a closed reduction gained full ROM within a range of 2-40 weeks, with all patients experiencing an uneventful recovery. Likewise, our patient returned to her full range of activities within 4 months and did not dislocate her patella again.

Conclusions

In summary, we present a rare case of an intra-articular vertical patellar dislocation in a pediatric female patient. The classification system we describe is put forth to help provide appropriate care and prevent further injury and complications. We believe that determining the location of the patella relative to its anatomical space, its axial rotation or revolution, as well as the directionality of the articular surface will provide sufficient information to determine the best maneuver to successfully complete a closed reduction under conscious sedation with a good outcome. In the event that a closed reduction under conscious sedation cannot be achieved, a procedure under general anesthesia is suggested.

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